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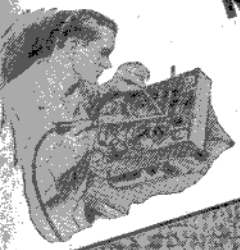
NATIONAL RADIO INSTITUTE, WASHINGTON, D. C.

No. 27 How To Align All-Wave Superheterodynes

RADIO SERVICING METHODS



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How To Align All-Wave Superheterodynes

BASICALLY, the procedure followed in aligning an all-wave receiver is similar to the one that you have already learned to use in aligning a one-band superheterodyne. The major difference is that there are additional short-wave bands that have to be aligned in the former. In some all-wave sets, also, there are special circuits, such as automatic frequency control or variable-selectivity i.f. amplifiers, that make alignment more complicated.

In this RSM Booklet, you will learn how to align all-wave a.m. receivers, including those having special associated circuits. The alignment of f.m., television, and high-fidelity receivers is discussed elsewhere in your Course.

BASIC PROCEDURE

The alignment order is the same for an all-wave superheterodyne as it is for a one-band super: the i.f. amplifier is aligned first, then the preselector and oscillator are made to track. Before going into the specific details of how to make these adjustments on various kinds of sets, let's see in general how they are made.

Align the I.F. Stages. To align the i.f. stages, connect the signal generator to the input of the first detector (or to the antenna-ground post if sufficient signal can be forced through the preselector). Connect an output meter to the set. Tune the signal generator to the i.f. frequency of the receiver, then adjust the i.f. trimmers for maximum gain (maximum output).

Align Preselector and Oscillator. Connect the signal generator to the antenna and ground post of the receiver (or couple it to the loop antenna, if one is used). Set the band-change switch on the receiver to the highest

frequency (shortest wave length) band, and tune both the receiver and the signal generator to a frequency near the high-frequency end of the band being aligned. (Be sure that the receiver dial reading is exactly the same as the frequency to which the signal generator is tuned.) Adjust the oscillator high-frequency trimmer associated with this band for maximum output, then adjust the preselector trimmers similarly. If the band has a low-frequency padder, tune the signal generator and the receiver to a frequency near the low end of this band, and make a rocking adjustment on the padder. Repeat the high-frequency adjustment after making a low-frequency adjustment.

► Proceed now to align the next lowest frequency band in exactly the same manner. Continue to align band after band until all bands have been aligned, including the broadcast band.

Now let's consider each of these steps in more detail to see what problems may arise in carrying them out.

I.F. ALIGNMENT

If the receiver does not have variable-selectivity controls, you can align the i.f. amplifier in exactly the same manner as you would a single-band set. The output meter may be: *1*, an a.c. type, connected across the voice coil or connected from plate to chassis of the power output tube; or *2*, a d.c. meter, used to measure the a.v.c. voltage. (Of course, if the set has a tuning eye or meter indicator, you can align for maximum closure of the eye or for maximum meter swing; in this case, you do not need an output meter.)

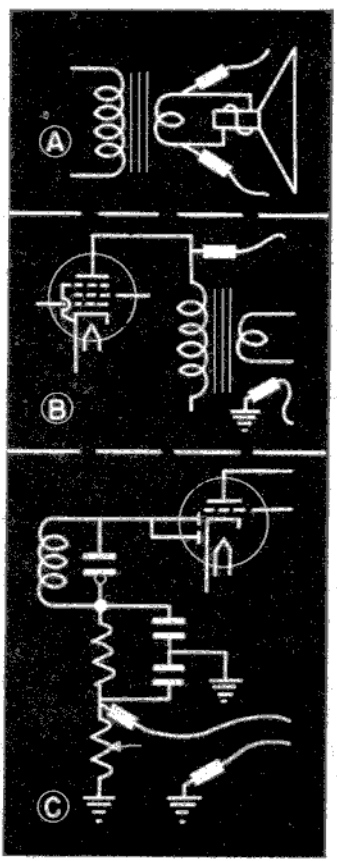
Identifying the First Detector. The signal generator is normally connected to the input of the first detector for i.f. alignment. This brings up the problem of finding out which tube is the first detector. If you have the manufacturer's instructions for the set, this will be easy, because the tubes will be identified. However, if you do not have the manufacturer's instructions, you can frequently find the right tube by noticing the types of tubes in the set. A tube such as a 6A7, 6A8, 6SA7, 6K8, 12SA7, or 6L7 is generally used as the first detector.

If you do not find one of these tubes in the radio, it will be necessary to identify the stage from its connections. The plate of the first detector tube is connected to the primary of the input i.f. transformer, which is usually rather easy to identify, and the grid of this tube is generally connected to r.f. tuning circuits. (In a few all-wave receivers that use an r.f. stage and a loop antenna, the input circuit of the first detector is not tuned.)

Coupling the S.G. to the Set. You will frequently find that the manufacturer's instructions recommend the use of a blocking condenser in the hot lead of the signal generator for i.f. alignment. (This may be listed under "dummy antenna" in the instructions.) The blocking condenser is used to prevent the s.g. input circuit from short-circuiting the a.v.c. supply of the first detector.

You should know whether your signal generator already has such a blocking condenser. Many do. If it has, you can clip the s.g. hot lead to the grid terminal of the first detector stage, and then connect the ground lead of your s.g. to the set chassis.

If your s.g. does not have a built-in blocking condenser, then it is desirable to connect one in series with the hot lead. The capacity of this condenser is not critical. You will find that the



Three ways of connecting a multimeter to a set for use as an output indicator: A, across the speaker voice coil; B, from the plate of the output tube to the chassis; C, across the diode load. In the first two methods, connect your multimeter as an output meter; in the third, in which you are measuring the a.v.c. voltage, connect the meter as a d.c. voltmeter, with the plus lead going to ground.

values recommended by manufacturers differ widely, but actually any condenser from .01 to .1 mfd. is satisfactory.

► If the first detector is a single-ended tube, such as a type 6SA7 or 12SA7, you may encounter some difficulty in making connections to the control-grid terminal underneath the set chassis. Sometimes you will find it possible to connect the hot s.g. lead to the tuning condenser stator plates in the section that is used to tune the first detector input. However, if this connection is difficult too, it may be easiest to connect the s.g. to the antenna-ground terminals, or to couple it to a loop antenna, if one is used. In most instances it is possible to force the i.f. signal through the preselector when the wave-band switch is set to the broadcast band and the set is tuned to the low-frequency end of the broadcast range.

Finding the I.F. Value. When the s.g. is connected, it must be tuned to the i.f. value of the receiver. The manufacturer's information can be consulted to learn what this is. However, if you do not have the manufacturer's instructions, and the receiver is in playable condition, it is probable that the i.f. section is adjusted to a frequency not far from the correct one. Starting at 500 kc., tune your s.g. downward over the i.f. range until you encounter a frequency that will pass through the receiver with the greatest volume. If this frequency is near one of the standard i.f. values of 262, 456, 465, or 480 kc., then use the nearest standard frequency for the alignment.

► A word of caution—you may get a signal through the set with the s.g. tuned to some frequency that is not the i.f. frequency. This will occur if the s.g. signal (or some harmonic of it) combines with the local oscillator output of the receiver to produce an i.f. signal. You can always tell whether you have a spurious signal of this sort by changing the setting of the receiver dial. This shifts the oscillator frequency, and so will cause a spurious signal to disappear. However, changing the receiver dial setting will have little effect if the proper i.f. frequency is being fed in from the s.g., even when it is being fed through the preselector.

It is customary to allow the set to warm up for from

ten minutes to half an hour before aligning it, and if the signal generator is a.c.-operated, to allow it to warm up, too. This assures that both will be stable and that the alignment will hold after it is made.

Adjusting the I.F. Trimmers. When you are ready to align, adjust the i.f. trimmers for maximum output. Repeat the adjustment to eliminate the effects of interaction between trimmers.

In an ordinary all-wave set, this adjustment is made simply by turning the two trimmers associated with each i.f. transformer. There are three forms of high-fidelity receivers, however, that require different methods of aligning the i.f. amplifier.

► One of these has the standard two trimmers, but also has a variable-selectivity control on the front panel of the receiver. This control shifts the i.f. amplifier from a band-pass, high-fidelity characteristic to the usual sharp-selectivity characteristic. To align the i.f. amplifier in such a set, turn this control to the sharp-selectivity position, and adjust the two trimmers for peak response. When this is done properly, turning the selectivity control to its other position will provide just enough additional coupling to give a broad-band response when higher fidelity is desired.

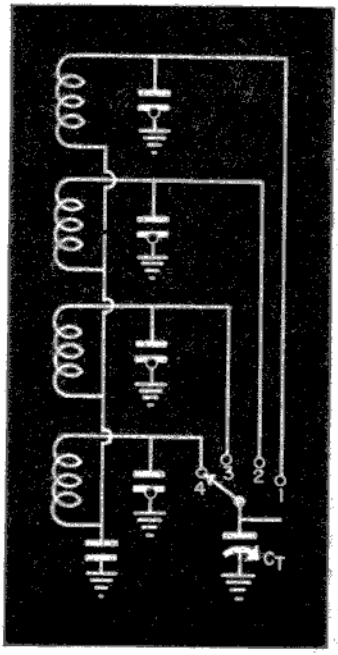
► Another kind of high-fidelity receiver has a third trimmer on each i.f. transformer. This type of set also has a variable-selectivity control switch, but the alignment method used is generally different from the one just discussed. Often the trimmer going to the center set of coils is adjusted first for *minimum* response, then the other two are adjusted for maximum response, and finally the center one is again adjusted, this time for *maximum* response. However, all receivers of this type cannot be adjusted in exactly the same way, so you will have to consult the manufacturer's instructions to be sure you make the adjustment correctly.

► The true high-fidelity receiver is not usually all-wave; rather, it is a single-band set designed for local station reception. Such a set is designed only for band-pass i.f. response; the trimmers are therefore adjusted to give broad-band response instead of peak response. Essentially, this is done by adjusting one trimmer on

each i.f. transformer to give maximum response at a frequency a few kc. *above* the i.f. frequency, and by adjusting the other trimmer to give maximum response the same number of kc. *below* the i.f. frequency. For maximum fidelity, it is usually necessary to use additional equipment—a cathode ray oscilloscope and a wobbulated signal generator—to align such receivers. However, it may be possible to make the band-pass adjustment reasonably well by tuning a standard s.g. carefully the proper number of kc. above and below the proper i.f. frequency. If it is possible to use this latter method, the manufacturer's instructions will usually tell you just what to do.

As we said before, the details of aligning high-fidelity receivers are given elsewhere in your Course. We have mentioned the various methods that may have to be used on them only to point out the fact that you should not attempt to align such sets by the ordinary procedures.

ALIGNING THE PRESELECTOR AND OSCILLATOR



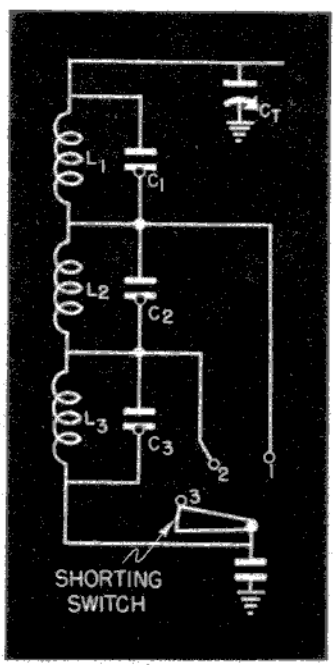
This is the preselector circuit of an all-wave receiver using independent tuned circuits for each band. As you can see, the coil and trimmer of each circuit are separate from those in all the other circuits. You can align the bands of such a receiver in any order you wish.

Once the i.f. amplifier is aligned, you can turn to the preselector and oscillator. The all-wave receiver has, of course, a number of preselector and oscillator circuits—one of each for each wave band. There are two major systems of providing these circuits. In one, each circuit has its own set of coils, trimmers, and padders. In a set of this sort, the bands can be aligned in

any order—that is, you can adjust the broadcast band first if you want to, then skip from short-wave band to short-wave band.

The other system utilizes a single set of coils for all bands; the coils are provided with taps, and as much of each coil is used for each band as is needed to give the necessary inductance. For example, the highest frequency band uses one section of the coil; the next highest frequency band uses that section plus another section, and so on. A set with this arrangement, known as the series coil connection, MUST be adjusted from the highest frequency band downward. The setting of the trimmers in each circuit affects the capacities in the other circuits, and it is impossible to compensate for this unless the highest frequency band is aligned first. Proceeding this way, band by band, you will align the broadcast band (or low-frequency weather band, if the set has one) last.

Naturally, if you have the manufacturer's instructions, you won't have any trouble no matter which system the set uses; these instructions will list the adjustments in the order in which they should be performed if the order is important. However, when you do not have the manufacturer's instructions, you must either



This is a typical use of a series coil connection in a preselector circuit. The shorting switch is part of the wave-band switch. When this switch is turned to position 1, it touches the contact of position 2 also; coils L_2 and L_3 are then shorted, leaving only L_1 to be tuned by condenser C_T. When the switch is turned to position 2, coil L_3 is shorted; coils L_1 and L_2 are then in series and tuned by C_T. When the switch is in position 3, all three coils are in series and tuned by C_T. To align this set, you must turn the switch first to position 1 and adjust trimmer C_1, then to position 2 and adjust C_2, and finally to position 3 and adjust C_3.

examine the set carefully to determine which type it is, *or follow the general rule of aligning the highest frequency band first in all cases,* working downward through the lower frequency bands.

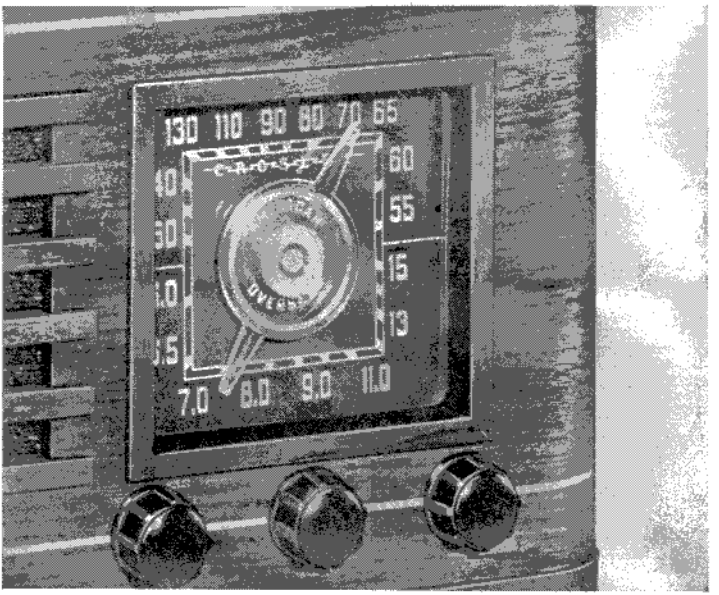
Dial Pointers. Before adjusting the preselector and oscillator, make sure that the dial pointer tracks over the dial properly; if it does not, it will be impossible to get the oscillator and preselector to track. The manufacturer's instructions will tell you of any calibration marks to which the pointer should be adjusted when the gang tuning condenser is fully open or fully closed. If you have no such instructions, determine whether the pointer covers the entire scale as the tuning condenser is turned from the open to the closed position. If it seems to cover the scale, with about the same amount of overlap at each end, you can usually be sure that the pointer is in adjustment.

If the scale is circular, like the one shown in Fig. *1,* usually the pointer should be adjusted to be perfectly horizontal—in line with the center horizontal line—when the tuning condenser is fully open or fully closed.

If the pointer has slipped, you can usually loosen the screw holding the pointer, or disconnect the pointer from the dial cord, and slip it to the proper position. Once it is in position, fasten it securely.

► In some of the older radio receivers the dial scale is attached to the tuning-condenser assembly, and a fixed indicator is attached to the cabinet. When one of these sets is removed from the cabinet, there is no means of indicating the frequency to which the set is tuned. Before you remove such a set from the cabinet, turn it to some frequency that is clearly marked on the dial. Take it from the cabinet carefully, so as not to disturb the tuning. Then make a marker from a piece of wire, attach it to the chassis, and adjust it so that it indicates the same frequency as the pointer did in the cabinet.

► On more modern receivers, the dial scale may be attached to the cabinet so that it remains in place when the set is removed. On most sets like this, the tuning condenser dial drum (a part of the receiver) has on it an auxiliary scale, calibrated from zero to 100 or from zero to 200, that is intended to be used for alignment



Courtesy Crosley Corp.

FIG. 1. Circular dials of this sort are often used on small 2-band receivers. Larger sets generally use either a slide-rule dial or a large circular dial.

purposes. The manufacturer's instructions give the numbers on this scale that correspond to the main dial frequency settings.

Identifying the Adjusters. Once you have found that the pointer is in adjustment, or you have adjusted it, you are ready to align the receiver. Your first problem is to identify the many trimmers and padders that may be on the receiver. Once again, the manufacturer's alignment instructions are very desirable. These instructions give a sketch of the trimmer layout, and tell you which trimmer should be adjusted for each wave band and for each band setting. Typical examples are given in Fig. *2* and Fig. *3*.

If you do not have the manufacturer's instructions, there are two ways of finding out which band each trimmer is used in. One way is to tune in a signal from the s.g. and then adjust the trimmers, one at a time, to see which ones affect the response. When a trimmer adjustment causes a change in the output meter reading, you know that this trimmer is used in the wave band cor-

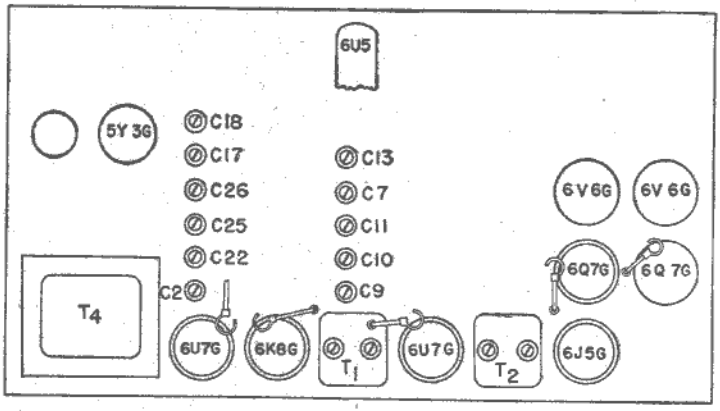


FIG. 2. As part of his alignment instructions, a set manufacturer usually supplies a diagram similar to this of trimmer locations.

responding to the signal generator setting.

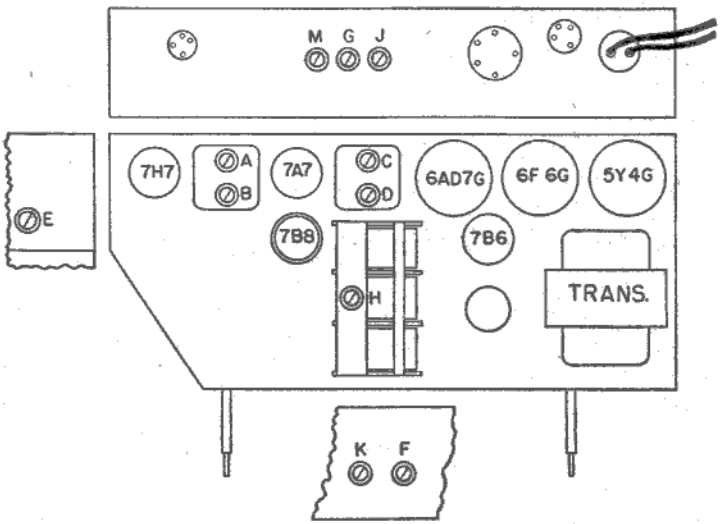
Sometimes just touching the screw with a metal screwdriver will be sufficient to produce a change in the output meter reading if the trimmer is active at the frequency being tuned in. Or, in the case of a book-type trimmer, pressing down on the top plate of the trimmer with an insulated alignment tool will cause a large change in capacity, producing a considerable change in the output meter reading if the trimmer is active.

As we said earlier, there is a certain amount of inter-

OPERATION	CONNECT TEST OSCILLATOR TO	DUMMY ANTENNA	INPUT SIGNAL FREQUENCY
1	CONVERTER GRID	½ MFD.	455 KC.
2	ANT.–GND.	400 OHMS	455 KC.
3	"	"	18 MC.
4	"	"	16 MC.
5	SINGLE TURN LOOP LOOSELY COUPLED TO LOOP ANTENNA	—	1600 KC.
6		—	1400 KC.
7	"	—	600 KC.

action between the various trimmers in all-wave receivers that use the series connection of coils for all bands. For this reason, always start with the highest frequency band when you are identifying trimmers by the method just described. When you have located the trimmers for that band, switch the set and the s.g. to

FIG. 3. Another example of a trimmer location diagram, plus the alignment information furnished with it.



BAND	SET DIAL AT	ADJUST TRIMMERS	PURPOSE
BROADCAST	600 KC.	A, B, C, D	I. F. ALIGNMENT
S. W.	6.5 MC.	E	ADJUST WAVETRAP FOR MINIMUM
S. W.	18 MC.	F	SET TO SCALE
S. W.	16 MC.	M	ALIGN ANT.
BROADCAST	1600 KC.	K	SET TO SCALE
"	1400 KC.	H, G	ALIGN DET. AND ANT. STAGE
"	600 KC.	J	ROCK GANG AND ADJUST FOR MAX.

the next highest frequency band, and repeat the identification tests (but do not make tests on the trimmers already identified). Continue through the other bands in descending order of frequency. Making tests in this order will reduce the chances of causing a response in one band when you adjust a condenser that belongs in another.

► The other way of identifying trimmers is to trace the various circuits to determine where each trimmer is connected. This is not easy, particularly in sets in which the trimmers are scattered over the chassis. However, in most receivers the trimmers are collected into groups; once you have identified the order in which the groups are connected to the wave band switch, you can then determine the band in which each is used.

The problem is additionally complicated by the use of padders in the oscillator section of the receiver. As you know, padder condensers are used to obtain equal tracking. A system of padding must always be used in an all-wave receiver. However, this does not mean you will always find an adjustable padder in each band—the higher frequency bands are frequently padded by means of fixed condensers. If you can find no variable padder in a high-frequency band *after making a careful search*, you can assume that a fixed condenser is used.

Alignment Procedure. Let us suppose that you have the manufacturer's instructions, or have identified the trimmers, and that the dial pointer is properly adjusted. To align the preselector and oscillator sections, proceed as follows:

Connect the signal generator to the antenna and ground terminals of the receiver, or couple it to the loop antenna. When a loop antenna is used, you can couple to it either by placing a single piece of wire around the loop, as shown in Fig. *4*, or by clipping the hot lead from the signal generator to the form on which the loop is wound (Fig. *5*).

Set the band-change switch to the highest frequency band. Tune the s.g. to the proper frequency near the high-frequency end of the band being aligned. Then adjust the oscillator trimmer and the preselector trimmers associated with this band for maximum output.

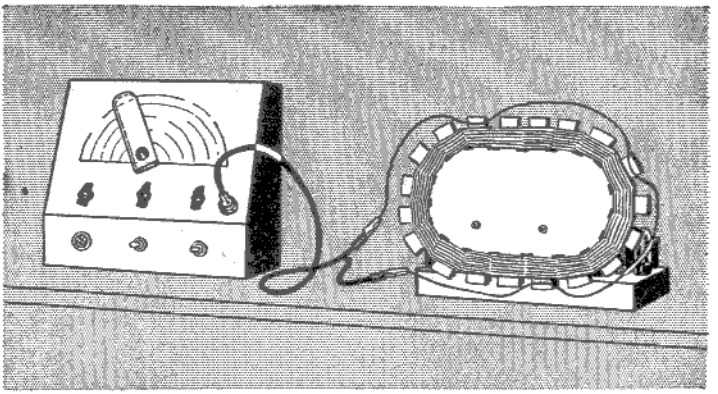


FIG. 4. A wire looped loosely once around the loop-antenna form and connected to the s.g. leads will provide sufficient coupling for your s.g. signal.

If this band has an adjustable padder, tune to the low-frequency end of the band and make a rocking adjustment of the oscillator low-frequency padder. (Of course, no low-frequency adjustment is possible if a fixed condenser is used as a padder.) If you make this adjustment, go back to the high-frequency end of the band and re-adjust the oscillator high-frequency trimmer.

When the highest frequency band is aligned, tune to the next highest frequency band, and align it in the same manner. Proceed band by band until all have been aligned.

ADJUSTING THE ALL-WAVE RECEIVER THAT HAS BEEN TAMPERED WITH

If someone has tampered with the adjusters on an all-wave receiver, your first problem is to get the receiver to play at all. It is usually best in this case to get the receiver to play on the broadcast band by aligning this band first. The reason for doing so is that the broadcast band is less critical in its adjustment than are the short-wave bands, so it is easier to make the set play on the former.

If the set has separate coils for each band, you can then proceed to align the short-wave bands in any order you wish. If, however, the set has series-connected coils,

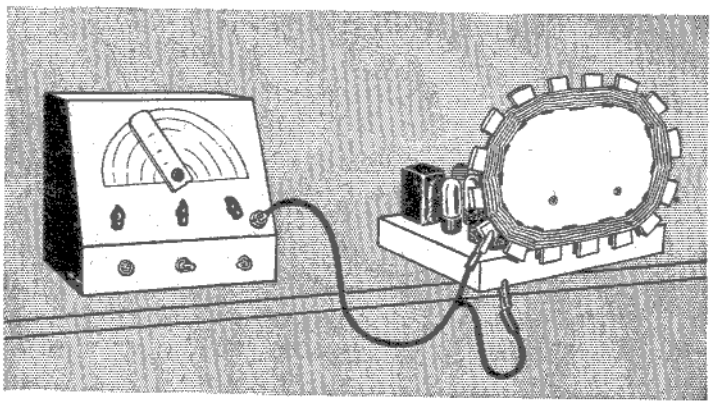


FIG. 5. Clipping the hot s.g. lead to the loop-antenna form is another way to feed a signal into the set. Clip the s.g. ground lead to the set chassis.

you must start aligning with the highest frequency band once the broadcast band has been made to work. Frequently, in the latter case, you will have to re-align the broadcast band after the higher frequency bands have been properly adjusted. In fact, since the adjustments made in one band affect those in the others, it may sometimes be necessary to go through the whole alignment procedure a second time, band by band, to get maximum response from the set.

ALIGNMENT NOTES

You may find the manufacturer recommends a dummy antenna for aligning the short-wave and broadcast bands. The purpose of the dummy antenna is to simulate the effect of the standard antenna on the preselector. A 400-ohm resistor is usually recommended for the short-wave bands, and it is simple to connect a 400-ohm resistor in series with the s.g. hot lead when the maximum results are desired.

The manufacturer may recommend a more elaborate L-C-R coupling for broadcast band alignment. However, unless you make instrument measurements, it is difficult to tell the difference between the results obtained with such a coupling, and those obtained without it. If you do not care to set up the network, then you can readjust the preselector trimmers when the receiver is

returned to the customer and the set is connected to the customer's antenna.

► You may find conflicting recommendations in regard to the s.g. output to be used. If you keep the output low, the automatic volume control (a.v.c.) circuit will be less effective, and the gain of the controlled tubes will be high. As a result, the input capacities of the tubes used in the various tuned stages will differ somewhat from those the tubes would have if a stronger signal were used. (As you learned in your Course, the input capacity of a tube depends upon the stage gain.) Therefore, if you use a low-level signal from your s.g. for alignment, the set will be slightly detuned when a signal of average strength is received. Conversely, if you use an s.g. signal of average level for alignment, the set will be slightly detuned when a low-level signal is received. In any case, the detuning will be too slight to produce an appreciable effect except on the upper short-wave bands, and even on them the effect will not usually be very noticeable.

In general, it is best to align with an output from the signal generator that will approximate the average incoming signal. Therefore, keep the output from the signal generator at a reasonable level—one that will give you a good reading, but not necessarily a very high one, on the output meter.

► You may encounter some difficulty in aligning a short-wave band if you make an improper adjustment of the oscillator high-frequency trimmer. As you know, a superheterodyne should be aligned so that the oscillator frequency is *above* the preselector frequency by the amount of the i.f. frequency. If any band is aligned so that the oscillator frequency is *below* the preselector frequency by the amount of the i.f., the set will still play at the high-frequency end of the band, but it will be impossible to make it track properly at the low-frequency end.

Such a misalignment cannot usually occur in the broadcast band, because the average oscillator trimmer cannot be tuned over a wide enough range at broadcast frequencies to cause this difficulty. However, the oscillator trimmer has a much wider tuning range on the short-wave bands—for example, a shift of 900 kc. can be ob-

tained on the 18-megacycle band by turning the trimmer screw less than half a turn. Therefore, in a short-wave band, it is often possible to set the oscillator by accident to a frequency that is under the preselector frequency by the amount of the i.f.

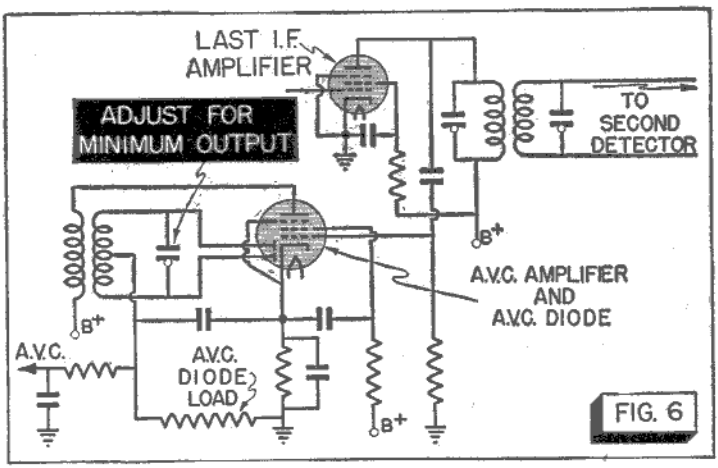
To avoid this difficulty, do not turn the oscillator trimmer very far when you are making a high-frequency adjustment on a short-wave band that is reasonably well aligned. However, if the set has been tampered with, or if you accidentally turn the oscillator trimmer far away from the correct setting, you had better make sure that the oscillator frequency is above the preselector frequency. To do so, adjust the set and your s.g. to a frequency near the high end of the band, and run the oscillator trimmer adjusting screw out slowly, being careful not to bring it out so far that the condenser comes apart. If the trimmer has a wide enough tuning range, you should pick up the signal at two different screw positions as you back the screw out. If you do, leave the screw at the outer position (the position that gives the trimmer less capacity). This will make it certain that the oscillator is above the preselector in frequency.

MINIMUM OUTPUT ADJUSTMENTS

There are two circuits in which a trimmer should be adjusted for minimum output rather than maximum. The more common of these is a wave trap in the antenna circuit, adjusted to the i.f. frequency.

To adjust an i.f. wave trap, proceed in the normal manner to align the i.f. circuits of the set. Then, with the s.g. connected to the antenna-ground posts (or coupled to the loop antenna), locate the i.f. wave-trap adjuster. Next, with the s.g. tuned to the i.f. frequency, adjust this trimmer to give *minimum* output. When thus adjusted, this trap will tend to block out any code signals or other interfering signals that may try to come in at the i.f. frequency of the set.

► The second minimum adjustment is found only in some receivers manufactured in the early 1930's. In these, the a.v.c. circuit is of the "amplified" type and has its own i.f. transformer. Usually there is but one



trimmer on this transformer, although occasionally there are two. Since this transformer feeds the a.v.c. network, it is necessary to adjust the trimmer to produce minimum output for the set. (The fact that the set output is minimum means that a maximum a.v.c. voltage has been developed.) Therefore, after aligning the i.f. amplifier in the usual manner, leave the s.g. connected as for i.f. alignment, and adjust the a.v.c. transformer trimmer or trimmers for minimum output.

A typical circuit of this kind (which, as we have just mentioned, will be found only on fairly old receivers) is shown in Fig. *6*. Usually there will be three i.f. transformers in a set that has this feature, but not all three-transformer sets are of this kind—some use a third transformer because they have two i.f. stages.

A.F.C. CIRCUIT ALIGNMENT

The automatic frequency-control circuit, used in a number of radio receivers made in the late 1930's, is intended to pull the oscillator into alignment even though the set is not perfectly in resonance. (You will learn the details of the operation of this circuit later in your Course.) It was used chiefly to assure accurate tuning in push-button receivers. Fig. *7* shows a typical discriminator section.

When you encounter a set having a.f.c., consult the manufacturer's instructions if they are available. If

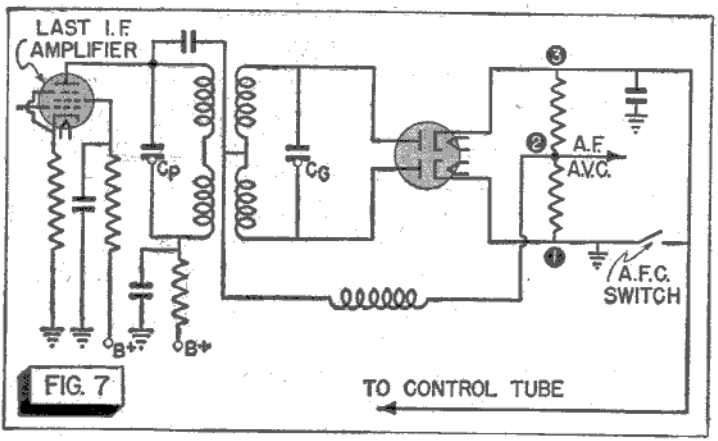


FIG. 7

not, follow this procedure:

First, connect an a.c. output meter, as usual, to the voice coil, or from the plate of the power output tube to ground. Or, if a d.c. meter is used, connect it to measure the a.v.c. voltage (between point *2* and chassis in Fig. *7*). Next, turn the a.f.c. switch to the OFF position to eliminate this feature. Align the set in the usual manner—the i.f. amplifier first (including trimmers C_P and C_G in Fig. *7*), then the preselector and oscillator trimmers and padders for all bands—with the a.f.c. switch off throughout the procedure.

After completing the alignment, tune the set to some frequency near 1000 kc., and tune the s.g. accurately to this same frequency. Be sure they are exactly in resonance, as indicated by a peak in the reading of your output meter.

Now, connect a high-sensitivity voltmeter (10,000 ohms-per-volt or better), or a vacuum-tube voltmeter, across the output of the discriminator circuit. In Fig. *7*, this is from points *1* to *3*. Turn on the a.f.c. switch, and adjust condenser C_G (Fig. *7*) until the high-sensitivity voltmeter reads *exactly* zero voltage. (The voltage can reverse in polarity. To make sure you have zero voltage, reverse the voltmeter connections to points *1* and *3*. Your voltmeter should still indicate zero voltage.) This adjustment is very critical. Make extremely accurate voltage readings, and make them with the adjusting tool removed from condenser C_G. (Leave C_P and the

other i.f. trimmers alone—only C_G is re-adjusted.)

When this adjustment is properly made, snapping the a.f.c. switch off and on should make practically no difference in the reading of your output meter. However, don't attempt to use the output meter to make the adjustment; only a sensitive d.c. meter connected as we have described will give the necessary precision.

THE NRI PRACTICAL TRAINING PLAN

You must have a signal generator and a multimeter (to be used as an output indicator) before attempting to gain experience in aligning sets. When you have this equipment, we suggest that you go through the following procedures twice on your set—once with an a.c. voltmeter connected across the voice coil (or from the plate of the output tube to ground), and once with a d.c. voltmeter connected to measure the a.v.c. voltage. This will teach you how to use both types of output meters. It is a good idea to know how to use both kinds, for then, in your future work, you can use the one that is easier to connect to the receiver you are aligning.

First, study carefully the alignment instructions furnished with your receiver. After you are sure you understand them, go through the alignment procedure, step by step.

Since your receiver is in good playing condition, it is probably not in need of alignment. However, go through the procedure anyway, just to be sure that the set is giving its maximum performance.

Then, deliberately misalign the i.f. amplifier by turning the i.f. trimmers a quarter- to a half-turn away from their proper settings. Operate the receiver to learn what effect this had on its selectivity and sensitivity. Now go through the procedure of realigning the i.f. amplifier.

Next, with the i.f. amplifier aligned properly, misalign the oscillator and the preselector section of the broadcast band. Again notice the effect on the selectivity and sensitivity of the receiver, then re-align it.

After you have become thoroughly familiar with the procedure of aligning the i.f. and broadcast bands, practice aligning the short-wave bands if your set is an all-wave type.

Next, deliberately turn all of the trimmers to simulate a set that has been tampered with. Usually anyone tampering with a set will tighten the adjusters, so screw them down until they are all reasonably tight. Try out the set now. You will probably find that nothing whatever can be received. Finally, re-align the set completely.

After you have finished all the practical training in alignment suggested above, you will be reasonably quick about making your adjustments on your own set. Now all you need is the experience of working on other receivers that have trimmers in different locations, so you can become familiar with the problems of locating trimmers and of following different procedures.

Each time you deliberately misalign a set, be sure you notice the effect your action has on both the sensitivity and selectivity. This is very important—the response of a set is one of the few clues you will have that show that re-alignment is needed.